NERRS Science Collaborative Progress Report
Period: 03/01/12 through 08/31/12

Project Title: *Legacy effects of land-use change and nitrogen source shifts on a benchmark system: Building capacity for collaborative research leadership at the Grand Bay Reserve*

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Report compiled by: R. H. Carmichael (PI)

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A. Progress overview: State the overall goal of your project, and briefly summarize in one or two paragraphs, what you planned to accomplish during this period and your progress on tasks for this reporting period. This overview will be made public for all reports, including confidential submissions.

Research goal
To measure land-use related N source and pathogen changes through time and define the resulting effects on ecosystem and human health in Grand Bay, AL by combining data from land-use models, sediment cores, modern sediment and water samples, ancient shell middens, living native and transplanted bivalves, and environmental attributes that cover time periods from up to 3000 years before present to 2020 for three subwatersheds and their receiving waters.

Planned activities and anticipated accomplishments
For this term (Y2: Q3 & Q4), we planned to continue creating and refining landuse maps and projections; finish dating sediment cores & midden shells; continue processing native bivalve samples and estuarine attribute (YSI, water and sediment) sampling; analyze stable isotope and microbial data for water, sediments, and oysters; continue sampling relevant wastewater sources and continue sampling discharge; continue measuring oyster growth (cohorts and direct measurement); regularly update our Facebook page and discussion board; communicate with stakeholders; continue training students, technicians, and summer interns on technical methods; create metadata.

We have begun or accomplished all of these tasks, except final dating of midden shells. We were successful in sampling sediment core Pb-210 profiles allowing dating from Bayou la Batre, Bangs Lake, Bayou Cumbest, and Bayou Heron, with some cores dating back to the 1780's. These dates allow us to align our microbial, isotope, and land-use data across sites. A subset of ancient shells were processed and analyzed for $\delta^{15}N$ and $\delta^{13}C$. Preliminary results indicate significant chemical differences between shells from the three midden sites, and differences between ancient and modern shell. We are coordinating with enduser Dr. Ed Jackson to date midden shell samples and collect data that complements his existing data set. He has described our work as collaborators in his final report to the MS Department of Archives and History.

Based on discussions with co-PIs and end users in the beginning of Y2, we decided to include Bayou la Batre as an oyster transplant site in summer of Y2 to complement sediment core and wastewater treatment plant (WTP) sampling. We also began monthly WTP sampling at facilities in Moss Point, Pascagoula, and Bayou la Batre, MS in April 2012. We began a sanitary survey of stormwater pipes and other direct sources in May 2012, and sampled sources during dry and wet conditions.

We opted to conduct oyster transplant experiments at six sites for a second year to allow us to (1) compare oyster growth, isotopic signatures, and microbial accumulation between summers of 2011 and 2012, (2) observe seasonal variation in environmental attributes and resulting effects on oyster growth rates, microbial concentrations, and isotopic ratios, and (3) add an additional site near the Bayou la Batre WTP outfall in response to enduser interests.

B. Working with Intended Users:

- Describe the progress on tasks related to the integration of intended users into the project for this reporting period.
- What did you learn? Have there been any unanticipated challenges or opportunities?
- Who has been involved?

1. We continue our collaboration with end user Dr. Ed Jackson to date midden shell samples and collect data that complements his existing data set. He has described our work in his final report to the MS Department of Archives and History.

2. Integration Lead, Walton and graduate student Beth Condon (and PI Carmichael, to a lesser degree) maintained the project Facebook Page: http://www.facebook.com/pages/Grand-Bay-National-Estuarine-Research-Reserve-Science-Collaborative/153046948084497 (open to the public)

   Current 'likes' count of 74 (up 17% from the last report), with more than 200 viewers and 10 responders per week. Posts include research updates and images, particularly by graduate student Condon. This venue has proven useful to update participants and recognize and show appreciation for their efforts. In particular, the 'Reach' (defined as the number of unique individuals who have actually seen any content related to the Facebook Page) was substantial (Fig. 1).

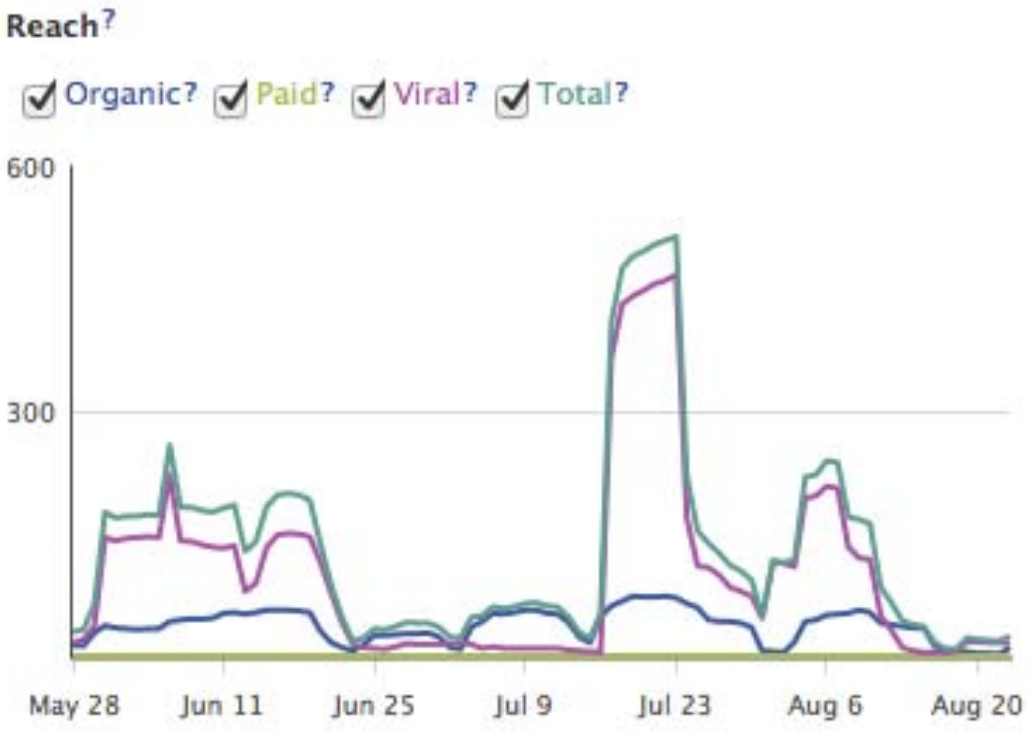

Fig. 1. 'Reach' in numbers of individual viewers of the Grand Bay National Estuarine Research Reserve Science Collaborative Facebook Page. **Organic** = the number of unique people who saw this post in their news feed, ticker or on your Page. **Paid** (N/A). **Viral** = the number of unique people who saw this post from a story published by a friend. These stories can include liking, commenting or sharing your post, answering a question or responding to an event.

- Has interaction with intended users brought about any changes to your methods for integration of intended users, the intended users involved, or your project objectives?
- How do you anticipate working with intended users in the next six months?

As described in the last report, results from 2011 sampling and conversations with researchers at the Coastal and Estuarine Research Federation (CERF) meeting in November 2011 raised questions about alternative sources of fecal indicator microbes and N to Grand Bay. We worked with FDA to plan seasonal and rain event-related sampling (discharge) and coordinated this effort with the ongoing EPA-funded project by Dr. Cebrian. We are now working with end users from MS Department of Marine Resources and Department of Environmental Quality and AL Department of Marine Resources from our most recent end user meeting to inform this effort. In response to this input, we included Bayou la Batre as an oyster transplant site in summer of Y2 to complement sediment core and wastewater treatment plant (WTP) sampling. We also began monthly WTP sampling at facilities in Moss Point, Pascagoula, and Bayou la Batre, MS in April 2012. We began a sanitary survey of stormwater pipes and other direct sources in May 2012, and sampled sources during dry and wet conditions. In the coming 6 months we will hold another PI Working Group meeting and another End user Participant meeting.

C. Progress on project objectives for this reporting period:

- Describe progress on tasks related to project objectives for this reporting period.
- What data did you collect?
- Has your progress in this period brought about any changes to your methods, the integration of intended users, the intended users involved or the project objectives?
- Have there been any unanticipated challenges, opportunities, or lessons learned?

Stakeholder participation

We continued our communication with the expanded stakeholder group defined in the last two quarters (DMR, DEQ; see summary of stakeholder meeting in last report). We have had some difficulty getting involvement with MS water quality department of the DMR due to their other obligations. We plan to continue working to include this group as well as new contacts from the Jackson County and Bayou la Batre Utility Authorities in our end user meetings planned for the next quarter.

Field sampling, lab work and data analyses

Sediment cores—Graduate student Beth Condon completed processing core samples for stable isotope and organic content analyses as well as Pb-210 dating. We were successful in sampling sediment core Pb-210 profiles allowing dating from Bayou la Batre, Bangs Lake, Bayou Cumbest, and Bayou Heron, with some cores dating back to the 1780's. These dates allow us to align our microbial, isotope, and land-use data across sites (Fig. 2). For example, elevated *C. perfringens* levels were found in Grand Bay sediments from as early as the 1850s (*c.f;* Bayou Heron and Bayou la Batre). During the past 200 years, Bayou la Batre sediments showed consistently higher levels of *C. perfringens*, compared to sediments from other sites. In contrast, at Bayou Cumbest and Bangs Lake, *C. perfringens* levels remained low, but spiked in the last 10-20 years. Samples from Point aux Chenes Bay were omitted due to a high amount of sediment mixing that did not allow Pb-210 dating. Due to the shallower water at Bayou Chicot, sediments could not be collected as at other sites; hand coring will be necessary.

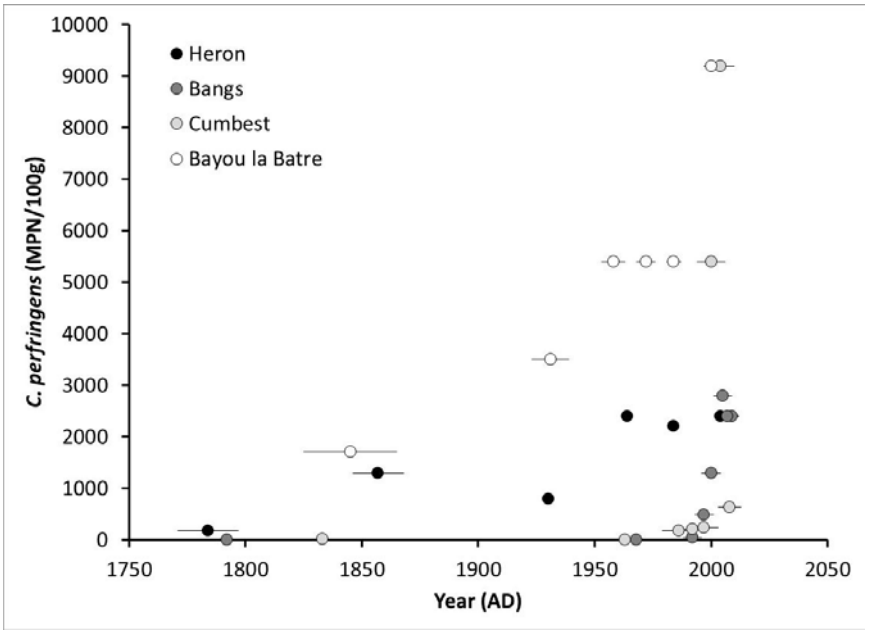

Fig. 2. Concentration of *C. perfringens* in sediments from sites near Grand Bay, MS, dated using Pb-210.

Oyster transplants—We conducted oyster transplant experiments at six sites for a second year to allow us to (1) compare oyster growth, isotopic signatures, and microbial accumulation between summers of 2011 and 2012, (2) observe seasonal variation in environmental attributes and resulting effects on oyster growth rates, microbial concentrations, and isotopic ratios, and (3) add an additional site near the Bayou la Batre WTP outfall in response to enduser interests. Analyses are ongoing.

Environmental & microbial data—We began monthly WTP sampling at facilities in Moss Point, Pascagoula, and Bayou la Batre, MS in April 2012. We began a sanitary survey of stormwater pipes and other direct sources in May 2012, and sampled sources during dry and wet conditions. We continued all other regularly scheduled environmental sampling as described in previous reports.

Midden shells—A subset of ancient shells were processed and analyzed for $\delta^{15}N$ and $\delta^{13}C$. Preliminary results indicate significant chemical differences between shells from the three midden sites, and differences between ancient and modern shell (Fig. 3.). Results follow the expected pattern for $\delta^{13}C$, showing heavier (more marine) values at seaward sites. Accordingly, Bayou Heron (furthest upstream site) had the most depleted $\delta^{13}C$ values, Bayou Cumbest showed intermediate values, and North Rigolets (closest to the open bay) had the most enriched $\delta^{13}C$ values. Similarly, $\delta^{15}N$ values in shells from Bayou Heron were lighter than values in shells from North Rigolets. We are coordinating with enduser Dr. Ed Jackson to date midden shell samples and collect data that complements his existing data set.

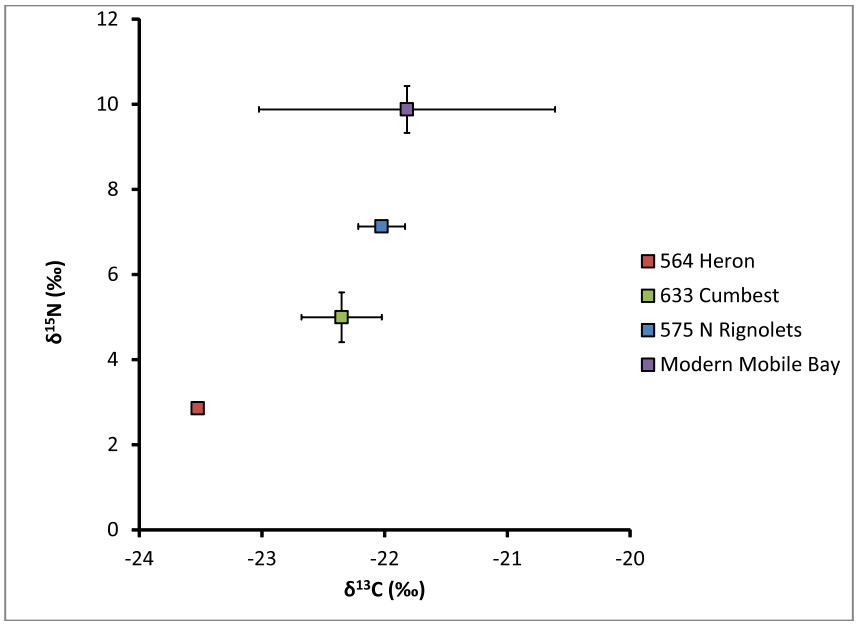

Fig. 3. N and C stable isotope values in the organic portion of oyster shell from three ancient midden sites near Grand Bay, MS and from modern shells in Mobile Bay, AL. Mean ± SE for n = 2 or 3 shells per site, except Bayou Heron, where n = 1 shell. Numbers reference specific midden sites on each river; Bayou Heron, Bayou Cumbest, and North Rigolets.

Technical training

- Co-I Calci (FDA) and student Condon continued working on laboratory techniques for the microbiology component of the project at the FDA Gulf Coast Research Lab on Dauphin Island.
- PI Carmichael and Condon continued training on shell slicing and acidification techniques in the Carmichael lab for application to midden shells provided by Jackson (USM).
- Condon incorporated a number of students into the project, by inviting them to assist with field and lab work. Many of these students expressed interest in marine science or biology as a career, and were able to learn techniques such as water quality sampling, oyster sampling, isotope filtering, and YSI data sonde calibration and data analysis. During summer 2012, PI Carmichael hosted intern, Beth Lauss, who worked closely with Condon, learning oyster transplant and growth measurement and stable isotope sample preparation techniques. Several other graduate and undergraduate students also assisted Condon and benefitted from learning field techniques and lab analyses. These students included: Mobile high school student Travis Goodloe; DISL REU undergraduate intern Arianna Johns; Carmichael lab interns Tommy Bilbo and Margaretmary Gilroy; DISL undergraduate students Burgundy Hanna and Lauren Jakubow; University of South Alabama Directed Study student Tyler Mason.

Land-use modeling

Co-PIs from GCRL continued refining land cover land use mapping.

- What are your plans for meeting project objectives for the next six months?

1. We will continue processing data from transplanted oysters, shell middens, and native bivalves, and analyzing data for estuarine attributes at each site. We will continue stable isotope analyses on sediment, water, and oyster samples, measuring bivalve growth and survival on transplanted oysters and based on native collections and core captures. We will continue extracting organic material from ancient bivalve shells (1000-2000 years old) and analyzing stable isotopes of this material.
2. Additional priorities include: (1) sample potential N and fecal indicator sources under a variety of conditions, (2) continue oyster deployments for the coming months, (3) send midden samples for ^{14}C dating.
3. We will continue operation and maintenance of the Facebook page and Google discussion board, make at least one public or scientific presentation to share data from the project, as well as continue data analyses and student and technician training.
4. We plan to hold one Working Group and one stakeholder meeting during the next 6 months.

D. Benefit to NERRS and NOAA: List any project-related products, accomplishments, or discoveries that may be of interest to scientists or managers working on similar issues, your peers in the NERRS, or to NOAA. These may include, but are not limited to, workshops, trainings, or webinars; expert speakers; new publications; and new partnerships or key findings related to collaboration or applied science.

1. See results above from dating efforts above.
2. Ongoing collaboration with the Grand Bay NERR and EPA project by Dr. J. Cebrian.
3. Condon also presented her work at the Gulf of Mexico Graduate Student Symposium on Dauphin Island in March 2012 and locally among members of the general public at the Dauphin Island Sea Lab's annual Discovery Day open house at Dauphin Island Sea Lab, Dauphin Island, AL in April 2012.

E. Describe any activities, products, accomplishments, or obstacles not addressed in other sections of this report that you feel are important for the Science Collaborative to know.

2012 Condon, Elizabeth D., Ruth H. Carmichael, H. Edwin Jackson. "Growth patterns of the eastern oyster, *Crassostrea virginica* from the Gulf of Mexico: records in ancient and modern shell". Gulf of Mexico Graduate Student Symposium, March. [oral presentation]

2012 Condon, Elizabeth D., Ruth H. Carmichael. DISL Discovery Day Public Open House: Hands-on demonstration and discussion of oyster shell midden sampling, growth pattern and stable isotope analysis. Dauphin Island Sea Lab, Dauphin Island, AL. [oral presentation and demonstration]